# The “who, what and where” of waste recycling research from 2005

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***Abstract*- This article exposes the analysis being made previous to build a map of science of waste recycling field. A first study was conducted in a proper database to detect the main publications in waste recycling field and to determinate which where the main ISI’s Subject Categories containing articles about waste recycling. The complete set of articles classified in these key Subject Categories corresponding to the interval 2005-2009 was downloaded and imported to Vantage Point software. After a thorough cleaning of the data, graphical representations were made to reflect in an easily readable way the “who, where and what” of this scientific field.**

## I. INTRODUCTION

The use of text-mining tools in Science and Technology databases can provide vital information to understand and foresee innovation processes, as well as to track the researching activities of countries, institutions or individuals [1] Information obtained can be classified in “first generation indicators” or “second generation indicators”depending on the nature of analysis [2]. This study is centred in the first generation ones, those based in the cardinality of the intersection or union of bibliometric units [3]. Foregoing work is oriented to deepen in more complex analysis destined to build a map of a subsector of science, namely, waste recycling science. An interesting example of mapping a science subsector is given in the reference [4].

The starting point of this study is the work conducted by Rio and Cilleruelo in [5]. A query was run upon the database “Environmental Sciences and Pollution Management”, trying to retrieve the articles related to waste recycling. The analysis of the set of items obtained allowed researchers to establish which were the main journals that properly cover the waste recycling field, among other valuable information [5].

This list of main journals was cleaned and a selection was made taking the next facts into account: their inclusion in the Journal Citation Reports and a minimum loading of 20 records in the initial dataset. These selected journals mainly pertained to the Subject Categories (SC) “Environmental Sciences” and “Environmental Engineering”, each one with a 36.5% and 21.2% of journals respectively, followed by a set of SC each of them containing no more than 5% of journals.

The next step consisted in downloading all the journal articles published between years 2006 and 2009 that have been classified in any of these two subject categories. A total of 109045 records were downloaded from ISI’s Web of Knowledge and imported to Vantage Point. This paper explains some conclusions extracted from the analysis of these records, as a previous step to the building of a waste recycling science map, following the method explained by Rafols and Leydesdorff [6] and [7]

## II. ANALYSIS AND CONCLUSIONS

### A. *Who*

To determine which the leading institutions in the retrieved dataset were, a thorough cleaning was made of the field “Affiliation” and top 15 institutions were ranked according to their scientific output. Fig.1 shows this ranking for years 2005-2009.

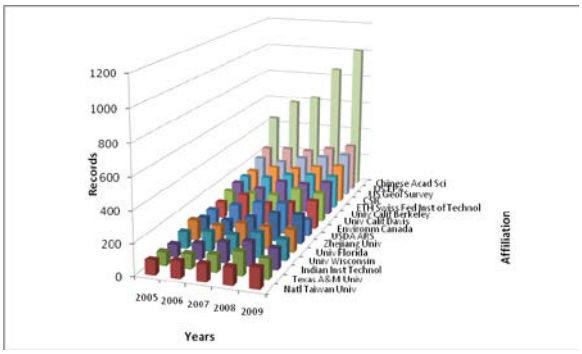


Figure1. Top 15 Researching Institutions for years 2005-2009

As can be seen, the Chinese Academy of Science clearly outnumbers the production of the rest of institutions. This academy is China’s highest advisory body in science and technology, and according to their website, their total staff amounted to 50300 people in 2008. The United States Environmental Protection Agency is the second main source, and the United States Geological Survey is in the third place. Two European institutions have their place in the fourth and fifth positions, namely, Spanish CSIC and Swiss ETH.

### B. *What*

An analysis of the “Author Keywords” field was conducted with the aim of determining the main concepts around which researching is taking place, and the evolution in the dominance of this concepts along years 2005-2009. Data were cleaned, combining one-by-one checking with Vantage Point fuzzy matching tools. Fig.2 shows the results of the analysis, a ranking of the top 20 concepts in the dataset.

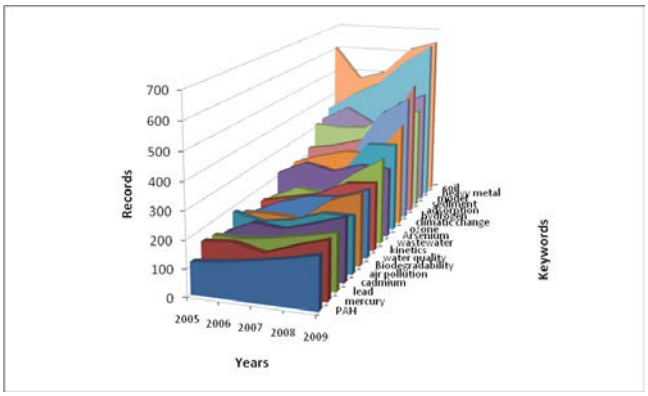


Figure 2. Evolution of top 20 terms across the years 2005-2009

Since the "Author Keywords" reflect, in opinion of the author, the key concepts contained in the article, some interesting hypothesis can be made from the lecture of the graphic:

The concepts "soil" and "heavy metal" lead the set, the former appearing in articles related to soil contamination and its general management, the latter being toxic elements characterized by the fatal effects caused by their accumulation in living organisms. Lead and mercury are the most relevant among heavy metals, since they individually appear in 16th and 17th positions of the ranking.

Phenomena of chemical kinetics and adsorption seem to be catching the attention of researchers, and the sharp, almost coincident, growth of terms adsorption and hydrogen should lead to further research about their relatedness and the role they play in this field.

Well-known topics like ozone-related ones and climatic change are also sources of an important amount of scientific production.

### *C. Where*

This step consists in determining which the leading countries are, in terms of scientific production in the retrieved dataset. The field "Countries" was not in optimal conditions, and the field "Affiliation, city and country" was preferred. Country name was extracted using the tools of Vantage Point and a thesaurus was applied after the extraction. Top 10 countries are shown in Fig. 3. United

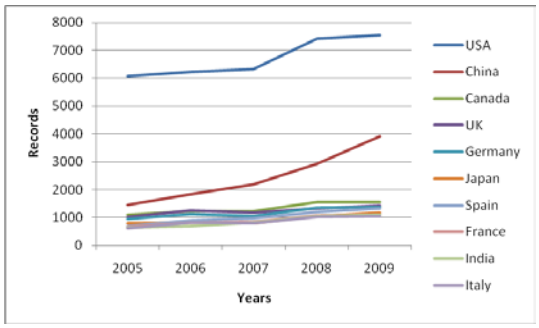


Figure 3. Production of each country for the years 2005-2009

States is clearly leading the scientific production in this field, followed by China, who has more than doubled its production in the last five years. The rest of countries show a moderated growth but are increasingly distant with the leaders.

### *D. Who is doing what*

A final chart is given where relationship between the top 5 affiliations and the most relevant topics they work with are shown. This is a quick way to identify the very nucleus of the researching fronts in each institution.

| Rec | Main Affiliation | Hot terms |
|---|---|---|
| 3533 | Chinese Acad Sci | Soil (238) |
| | | China (201) |
| | | Heavy metal (137) |
| | | Sediment (105) |
| | | Adsorption (70) |
| 1391 | US EPA | Model (37) |
| | | Sediment (34) |
| | | Particulate matter (32) |
| | | Air pollution (30) |
| | | Risk assessment (27) |
| 1218 | US Geol Survey | Mercury (52) |
| | | Sediment (36) |
| | | Water quality (25) |
| | | Model (23) |
| | | Wetland (23) |
| 1032 | CSIC | Soil (40) |
| | | Heavy metal (39) |
| | | Sediment (28) |
| | | Hydrogen (26) |
| | | Spain (24) |
| 994 | ETH Swiss Fed Inst of Technol | Soil(21) |
| | | Climatic change(20) |
| | | Ozone (20) |
| | | Model (18) |
| | | Heavy metal (15) |

Table 1. Main concepts detected in the scientific production of the top 5 affiliations.

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